Vegetational Changes in the National Key Deer Refuge-II

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This report is the second one of a continuing study started in 1968 to determine vegetational changes in the National Key Deer Refuge since the initial study in 1951 (Dickson, 1955). The first report (Alexander and Dickson, 1970) documented the changes in the northern part of Big Pine Key. The northern part was mostly a prairie in 1951 and currently supports an entirely different vegetation type from the pineland that covers most of the Key. The pineland is the subject of this study.

Most of the pineland occurs on four Keys: Big Pine, Little Pine, No Name, and Cudjoe. Of these, No Name is outside the Refuge and is being developed for housing. The pineland of Big and Little Pine Keys is of great importance for deer range. Little Pine Key is about 600 acres in size and of this about nineteen per cent is pineland. Big Pine Key is about 6,000 acres and about thirty-eight per cent pineland. Since a large portion of this pineland on Big Pine Key lies south of the Refuge, the amount of protected pineland within the Refuge is very limited. The study reported herein was confined to the pineland of Big Pine Key. A complete description of the Refuge can be found in the U.S. Fish and Wildlife Service pamphlet, R1-518 (1965).

The two objectives of the current study were to document the changes in the pineland since 1951 and to provide information that might be useful in decision making for vegetational management. The latter relates mostly to the question of the use of fire on the Keys to control plant succession in the pineland.

Data for the original study was collected during 1951-52 and for the current study 1969-70. These two will be referred to hereafter as 1951 and 1969 data and the comparisons will be considered to cover the changes over an eighteen year period. All the sites used for quadrats had been fire-free during the period.

Methods

Twenty quadrats, 3×100 feet were studied to analyze changes in the tree and shrub population. Thirty quadrats, 3×3 feet were

examined for herbaceous vegetation. The smaller quadrats were located within the larger. An attempt was made to randomly sample the area and follow procedures previously reported (Dickson, 1955), so that the 1969 data could be compared directly with those of 1951. Plant names, numbers, heights and per cent of cover were determined. The last was recorded as four classes: 1 (less than 1 per cent); 2 (1-5 per cent); 3 (6-25 per cent), and 4 (26-50 per cent). Frequency figures are the percentage of quadrats in which a species occurred. Density values are the average number of individuals per quadrat. Counts for trees and shrubs were converted to plants per acre. Plants browsed by deer were noted, based on information determined in 1951 from stomach and pellet analyses, and direct observations. Plant names used are from the checklist of Lakela and Craighead (1965).

Results and Discussion

Comparison of Tables 1 and 2 shows that 20 woody species were listed in 1951 and 25 in 1969. Of the 25, nine were new to the list and four species of the 1951 study were not found in 1969. The new species are in the last half of the 1969 list and represent species that are found in mature pinelands, usually as invasion species leading toward a climax forest. The one exception is important. It is the exotic *Schinus terebinthifolius*, locally called Florida holly or Brazilian pepper. As is the case with many exotics, this one is spreading rapidly throughout the warmer areas of Florida. It is bird-spread and will form dense stands at the expense of native vegetation. It should be eliminated when found in the Refuge. One of the four 1951 species not found in 1969 is *Reynosia septentrionalis*. It is very common on the northern end of the Key (Alexander and Dickson, 1970). In 1951 it was listed but with low frequency. It was not seen in any quadrat, nor contiguous pineland areas in 1969. The other three, not counted in 1969, *Suriana, Rhacoma* and *Jacquinnia*, were seen occasionally but did not occur in the quadrats. *Cassia bahamensis*, occurring in 1969, did not appear in the 1951 quadrats.

Pines have doubled in number during the 18 years. Several size classes are present. However, there is a significant reduction in the

TABLE 1
Density per Acre of Trees and Shrubs by Four Size Classes, 1951

Species	Under 1′	1′–4′	4′–12′	12′–55′	Total	Freq.	Cover	Deer Food
Coccothrinax argentea	1844	726	58		2628	100	3	*
Randia aculeata	1162	188			1350	50	1	*
Eugenia longipes	595	566			1161	90	3	
Pithecollobium guadelupense	247	639	116		1002	40	1	*
Pisonia rotundata	218	450			668	90	2	
Pinus elliottii var. *densa*	43		102	378	523	90	4	*
Metopium toxiferum	479	29			508	20	1	
Serenoa repens	87	392			479	60	3	
Reynosia septentrionalis	44	261			305	10	2	
Byrsonima cuneata	58	159	15		232	80	2	
Thrinax microcarpa	29	145	44		218	70	2	*
Conocarpus erecta	44	29	29		102	30	2	*
Erithalis fruticosa	15	87			102	10	1	*
Rapanea guianensis	44	43			87	30	1	
Acacia peninsularis		29			29	10	1	*
Sophora tomentosa	15				15	20	1	
Jacquinnia keyensis		15			15	10	1	*
Rhacoma crossopetalum			15		15	10	1	
Suriana maritima	15				15	10	1	
Torrubia longifolia			15		15	10	1	*
Totals	4939	3758	394	378	9469			

TABLE 2
Density per Acre of Trees and Shrubs by Four Size Classes, 1969

Species	Under 1'	1'–4'	4'–12'	12'–55'	Total	Freq.	Cover	Deer Food
Coccothrinax argentea	378	1016	203	7	1604	100	3	•
Pithecollobium guadelupense	276	552	232		1060	50	2	•
Pinus elliottii var. *densa*	319	247	189	290	1045	95	3	•
Eugenia longipes	276	661	14		951	85	3	
Thrinax microcarpa	203	290	196	15	704	90	3	•
Pisonia rotundata	167	319	15		501	95	1	
Byrsonima cuneata	51	225	7		283	50	2	
Randia aculeata	189	87			276	25	1	•
Metopium toxiferum	87	102	29	7	225	45	2	
Cassia bahamensis	102	43			145	25	1	
Conocarpus erecta	58				58	5	1	•
Serrenoa repens		51			51	25	1	
Erithalis fruticosa	29	15			44	10	1	•
Schinus terebinthiofolius	29				29	5	1	
Myrica cerifera		7	15		22	10	1	
Piscidia piscipula	22				22	5	1	
Sophora tomentosa		15			15	10	1	
Torrubia longifolia		7	7		14	5	1	•
Coccoloba uvifera		7			7	5	1	
Bumelia celastrina		7			7	5	1	
Guettarda scabra		7			7	5	1	
Acacia peninsularis		7			7	5	1	•
Lantana involucrata	7				7	5	1	
Rapanea guianensis	7				7	5	1	
Ficus brevifolia		7			7	5	1	
Totals	2200	3672	907	319	7098			

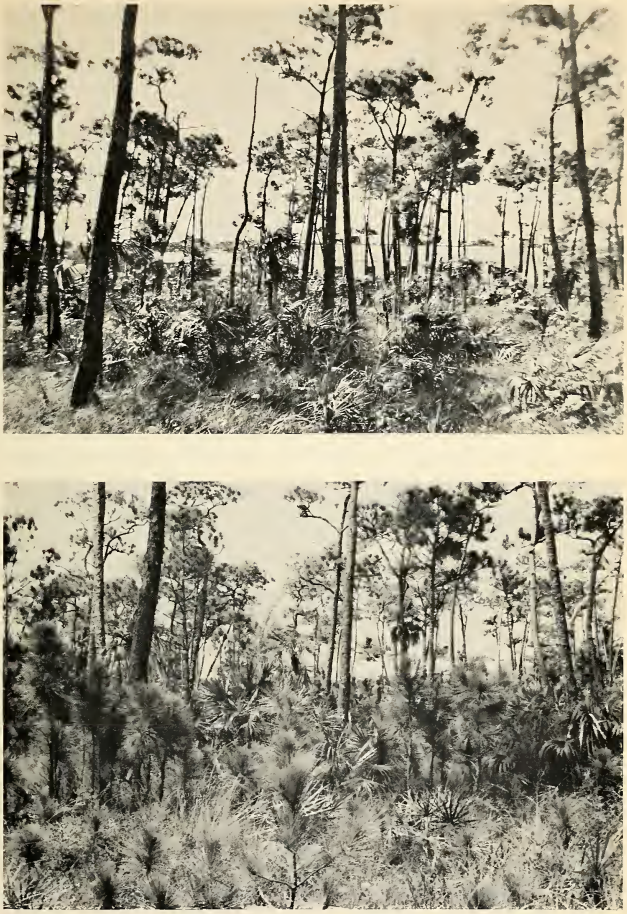

Fig. 1. Upper 1951 photograph; lower 1970 photograph. Note the difference in young pines.

number of pines over twelve feet tall. Two hurricanes (1960 and 1965) affected the area, and there were many fires prior to 1951 that weakened the older trees. Tree falls and standing dead trunks

are not uncommon. Figure 1 gives a fairly accurate picture of the increase in young pines. The photographs were taken at the same location.

Palms account for a great percentage of the total plant cover. *Coccothrinax argentea*, silver palm, totals are reduced considerably in the 1969 data. This is strongly reflected in the seedling count. At the same time more large specimens were counted. For some reason(s), the current reproductive rate is definitely less than during the period preceding the 1951 study. *Thrinax microcarpa*, key thatch palm, increased about three times during the 18 years and appears to be reproducing at a steady rate as evidenced by the first three size classes being well represented in the population. *Serenoa repens*, saw palmetto, appears to be failing significantly. This is considered a sampling problem. It is still locally abundant, especially near the depressions in the limestone. These limestone sinks were not encountered when plots were positioned in 1969.

Pithecolobium guadelupense, slightly increased its significance in the habitat. *Byrsonima cuneata* was very stable in density but reduced in frequency. *Eugenia longipes* remained the same in cover but only half as many seedlings were found in 1969. *Metopium toxiferum* increased in cover and frequency, but showed a drastic drop in seedlings in 1969. *Randia aculeata* and *Pisonia rotundata* appear to be failing. Small *Erithalis* plants were so closely cropped that they were hard to identify and larger plants were browsed as high as the deer could reach.

The differences between the totals in Table 1 and 2 are as follows. There were 2,371 fewer woody plants per acre at the end of the observation period than at the start. There were fewer tall pine trees. There was an increase of about 500 individuals per acre in the 4′-12′ class. This increase reflects the growth rate. The datum on the under-one-foot class is considered very significant in that there were 2,739 fewer individuals per acre in 1969. This is more than a 50 per cent reduction from the 1951 counts. Three possible reasons are; lack of fire, drought occurrence and new mosquito ditches.

According to the Refuge records none of the quadrat sites was burned after 1951. However, fire has been common in the pineland prior to that time. Seedlings of many species are frequently com-

TABLE 3

1969-70 Understory Plant List

Acacia peninsularis	*Houstonia* sp.
Anemia adiantifolia	*Hypericum* sp.
Borreria terminalis	*Melanthera parvifolius*
Cassytha filiformis	*Mikania batatifolia*
Centrosema virginianum	*Morinda roioc*
Chamaecrista keyensis	*Phyllanthes pentaphyllus*
Chamaesyce conferta	*Physalis angustifolia*
Chamaesyce serpyllum	*Piriqueta* sp.
Chiococca pinetorum	*Pluchea foetida*
Chrysobalanus pallidus	*Polygala* sp.
Cirsium horridulum	*Polygala praetervisa*
Caladium jamaicense	*Pterdium aquilinum*
Cnidoscolus stimulosus	var. *caudatum*
Crotalaria maritima	*Pterocaulon undulatum*
Croton linearis	*Rhabdadenia corallicola*
Cynanchium blodgettii	*Rhacoma ilicifolia*
Dichromena colorata	*Rhynchosia parvifolia*
Ernodea angusta	*Ruellia hybrida*
Flaveria linearis	*Smilax havanenensis*
Galacti parvifolia	*Stylosanthes hamata*
Galium hispidulum	*Tragia saxicola*
Gerardia purpurea	Unknown (one)
Heliotropium leavenworthii	Grasses (several)

mon following fire and then the numbers decline. The rainfall record from the nearest station (Key West) shows that for the 10 years prior to the 1951 study the rainfall was close to their 36-year average of 37.6 inches a year. The study period years, 1951, '55, '56, and '61 were drought years. Owing to the rocky and almost soilless condition of the limestone surface, even moderate droughts could kill seedlings before establishment. In January of 1964 the Monroe County Mosquito Control District began a ditching program on Big Pine. By completion in December of 1965, a total of 4,976 acres (of about 6000) had been ditched (personal communication from Director J. V. Denis, Monroe County Mosquito Control District, Stock Island, Florida, 1971). These ditches are about sixteen inches wide, vertical-sided, and are deep enough to allow tide water to flow in them from the nearby open sea. This increases salt intrusion into the substrate and also increases the rate of rainwater runoff, thus reducing penetration of fresh water to the root zone. Both of

TABLE 4
Comparison of Common Understory Species

Species	1951			1969			Deer Food
	F	D	C	F	D	C	
Species Occurring in Top 15 on Both Sampling Dates							
1. Grass spp.	93	8.3	4	83	9.7	3	
2. *Chamaecristas keyensis*	37	0.9	3	72	3.0	2	
3. *Ruellia hybrida*	37	0.8	1	53	1.2	1	*
4. *Dichromena colorata*	27	0.9	1	47	2.0	2	
5. *Galactia parvifolia*	20	0.2	1	43	0.8	1	*
6. *Cassytha filiformis*	23	0.2	1	30	0.3	1	*
7. *Morinda roioc*	13	0.6	1	27	0.5	2	*
8. *Phyllanthes pentaphyllus*	23	0.2	1	27	0.6	2	
9. *Smilax havanensis*	23	0.4	1	23	0.5	1	*
1951 Species New to Top Fifteen in 1969							
10. *Melanthera parvifolius*	3	0.1	1	40	0.7	1	
11. *Ernodea angusta*	7	0.1	1	33	1.0	3	
12. *Anemia adiantifolia*	7	0.3	1	30	0.9	2	
13. *Crotalaria maritima*	7	0.1	1	30	0.8	1	*
14. *Polygala grandifloria*	3	0.1	1	30	0.4	1	
15. *Cirsium horridulum*	3	0.1	1	27	0.3	1	
Species in Top Fifteen in 1951 but not in 1969							
Gerardia purpurea	23	0.5	2	13	0.3	1	*
Croton linearis	20	0.3	3	13	0.2	1	
Chamaesyce scoparia	17	0.3	1	—	—	–	*
Flavaria linearis	13	0.3	1	17	0.2	1	
Pterocaulon undulatum	13	0.1	1	20	0.4	1	
Physalis angustifolia	10	0.4	1	3	0.1	1	*

(F=frequency, D=density, and C=cover.)

these conditions contribute to water stress on the plants. Water for survival is critical in this rocky and xerophytic pineland.

The understory species are mostly herbaceous. However, some like *Ernodea* and *Morinda roioc* become woody. In general, all understory species listed were less than a half meter tall. The 1951 list included 46 species; the 1969 included 45. Twelve species listed in 1951 did not appear in 1969. Eleven species listed in 1969 did not appear in 1951. These differences, in part, are probably due to seasonal differences in sampling. Table 3 is a complete alphabetical listing of understory plants for 1969. Table 4 summarizes the major changes that occurred and includes all plants that are prominent understory species. All of the other species listed in Table 3 occur

with a frequency of only 13 per cent or less and belong to cover class 1.

The data reflect a fairly stable population in the understory for the 18-year period. The range and extent of changes do not appear unusual for this habitat. Grasses are somewhat less common in 1969. This is probably due to shading, especially from the increasing height of the palm and shrub canopy and the lack of fire. The most obvious change in the understory is the increased amount of *Ernodea*. This vine-like shrub with prostrate branches grows in dense mats and can dominate sizeable areas.

The pineland has not changed in overall appearance as much as the northern prairie did under similar conditions and time (Alexander and Dickson, 1970). In the latter case, plant succession proceeded from an open prairie to the thicket stages of a climax forest. The moisture holding marl soil of the prairie as compared to the rocky dry soil of the pineland was probably the main factor in the differences in the rate of succession seen in these contiguous areas. The pineland is on a mass of limestone and roots are restricted mostly to the accumulated organic litter and a few shallow solution holes. Soil forming processes are slow in this environment and fires burn accumulated organic litter so that large areas of bare rock are repeatedly exposed.

That there is a rich assortment of species and their propagules to initiate succession is well documented by this study and the plant lists from previous studies (Dickon, Woodbury, Alexander, 1953; Dickson, 1955; and Franklin, 1968). In spite of the above edaphic restrictions on succession the pineland of the Keys will give way to the climax of broad-leaved West Indian species if given enough time (Alexander, 1958, 1967). This has been documented by Stern and Brizicky (1957) on nearby No Name Key and by Dickson (1955) on No Name and Little Pine Keys. Prolonged protection from fire was the major factor on both Keys. Based on the evidence from this study and Jack Watson's (Refuge Manager) estimate in 1970 of fire-free years on most of No Name Key, it took about 50 years for broad-leaved species to completely overcome the pine forest and limit its reproduction. This is about twice the time for similar stages to be reached on the mainland (Alexander, 1967). Deer-use of the open pineland on Big Pine Key indicates the desirability

of this type of habitat in the Refuge and fire is a natural means of maintaining an open pineland.

The use of fire for controlling and maintaining vegetation such as pinewoods is well established (Mutch, 1970). That fire improves the growing condition of deer browse species was observed in the earlier study (Alexander and Dickson, 1970). It is also known that a pineland with accumulated fuel of leaf litter and undergrowth is vulnerable to crown fire and death of the forest. Only a few references on the response of *Pinus elliottii* to fire could be found and these were for var. *elliottii* instead of the local var. *densa* (Fowells, 1965). Hayward and Barnetti (1936) stated . . . "it has been established as a fact that the highly desirable slash pine *P. caribaea* More. (now *P. elliottii*) reproduces only on areas protected from fire." This statement was expanded and clarified in a more recent report by Gruschow (1952). The latter has data showing that successfully controlled burning on young stands of this pine is not started until the trees are about 12 feet tall. Trees smaller than this will suffer serious setbacks. Kaufman stated that "for natural regenerations of slash pine (*Pinus elliottii* var. *elliottii* and var. *densa*), burning to prepare the seedbed is a common practice. After the seeds have fallen to the soil surface, until the young trees have achieved some size, fire can destroy all efforts for regeneration. Usually controlled burning in young stands is not started until the trees are two inches at d.b.h. (diameter at breast height 4 1/2 ft. above the soil surface) and about 15 feet tall. Under very optimum conditions, slash pine much smaller will successfully survive very carefully conducted controlled burning but the risks increase very much. The *densa* (South Florida) variety of slash pine is somewhat more fire tolerant than the *elliottii* variety" (personal communication from Professor C. M. Kaufman, School of Forestry, University of Florida, Gainesville, Florida, 1970).

It should be noted that the *densa* variety has not been subjected to the same management by fire as has the *elliottii* variety. Also there is the fact that much of what is known about the latter's reaction to fire has been learned in row-planted pines and in the flatwoods of mainland Florida. Not much is known about the reaction of the key-type pineland to fire. Historically, the Keys have suffered many wildfires. Fires have undoubtedly served to maintain the pineland and arrest succession throughout recent time.

Before completion of this manuscript, wildfire burned about 340 acres of pineland on Big Pine Key, June 5, 1971. The authors examined the burn on July 9. The purpose was to evaluate the effect on the local *densa* variety. The observations support the previously reported results given for the *elliottii* variety. Most of the trees of the 4′-12′ class and under were dead, except where for some reason the heat was not excessive. It should be noted that the area had been fire-free for 20 years or more and the fuel load was excessive. Most palms were recovering and many of the woody plants were sprouting from their root-crowns.

It has been reported that a pineland once existed on Key Largo (Alexander, 1953). Only a few of the pineland related species persist on this Key. This part of Key Largo has been fire-free for many decades and is now covered by a dense forest of West Indian broadleaved species. These observations indicate the pineland can be lost by total protection from fire as well as by ill-timed and severe burnings.

The problem becomes especially critical in the Refuge since the land mass is so small. Wildfire can be replaced by controlled burning. Proper periodicity of burns can be determined only by regularly conducted vegetation studies coupled with the need to maintain adequate deer browse.

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